The Consultative Committee for Space Data Systems

Draft Recommendation for Space Data System Standards

TIME CODE FORMATS

DRAFT RECOMMENDED STANDARD

CCSDS 301.0-P-3.1

PINK SHEETS

November 2008

2.2 CCSDS UNSEGMENTED TIME CODE (CUC)

2.2.1 T-FIELD DESCRIPTION

~~For the unsegmented binary time codes described herein, the T-field consists of a selected number of contiguous time elements, each element being one octet in length. An element represents the state of 8 consecutive bits of a binary counter, cascaded with the adjacent counters, which rolls over at a modulo of 256.~~

~~The basic time unit is the second. The T-field consists of 1 to 4 octets of coarse time (seconds) and 0 to 3 octets of fine time (subseconds). The coarse time code elements are a count of the number of seconds elapsed from the epoch. Four octets of coarse time results in a maximum ambiguity period of approximately 136 years. This allows a time code representation of time through the year 2094 for those which are referenced to the TAI epoch of 1958 January 1.~~

~~Zero to three octets of fine code elements result in a resolution of, respectively: 1 second; 2^{-8} second (about 4 ms); 2^{-16} second (about 15 µs); or 2^{-24} second (about 60 ns).~~

~~The CCSDS-Recommended epoch is that of 1958 January 1 (TAI), but other Agency-defined epochs may be accommodated as a Level 2 code.~~

~~This time code **is not** UTC-based and leap second corrections do not apply.~~

The T-field consists of a selected number of contiguous octets representing an integrated number of basic time units from a defined epoch along with an optional integer number of octets representing the elapsed binary fraction of the basic time unit. Each octet within the T-field represents the state of 8 consecutive bits of a binary counter, cascaded with the adjacent counters, which rolls over at a modulo of 256. The time code represented by the T-field shall increase monotonically without reversion.

The basic unit of time intended for correlation with Earth-based clocks is the second. The basic unit of time represented by the value of the T-Field is required to be defined in the metadata. The metadata also defines the epoch of the time and the number of octets of basic and fractional time units. This metadata can be provided by the P-field if self-identification is employed or by metadata external to the P-field.

The CCSDS-Recommended epoch is that of 1958 January 1 (TAI) and the recommend time unit is the TAI second for use as a level 1 time code. This time code is not UTC-based and leap-second corrections do not apply.

2.2.2 P-FIELD DESCRIPTION

Octet 1

Bit 0 = P-Field Extension ('zero': no extension; 'one': field is extended)

Bit 1 - 3 = Time code identification

001 — 1958 January 1 epoch (Level 1 Time Code)
010 — Agency-defined epoch (Level 2 Time Code)

Bit 4 - 5 = ~~(number of octets of coarse time) —~~ Number of octets of the basic time unit minus one*

Bit 6 - 7 = ~~(number of octets of fine time)~~ Number of octets of the fractional time unit

Octet 2

Bit 0 = P-Field Extension ('zero': no extension; 'one': field is extended)

Bits 1-2 = Number of additional octets of the basic time added to that specified in Octet 1

Bits 3-5 = Number of additional octets of the fractional time added to that specified in Octet 1

Bits 6-7 = Reserved for mission definition

~~*For the 1958 epoch, bits 4-5 must be "11" to ensure a long enough ambiguity period. The value in this field may be variable and shall be in the range of 0 to 3, corresponding to 1 to 4 octets.~~

3 SECURITY

3.1 SECURITY BACKGROUND

The time code formats are expected to be used to encode time values within selected transmitted parameters. It is also expected that these parameters may need to be protected from undetectable corruption, and sometimes the true value of the parameter will be required to be hidden.

The specification of such security services is outside the scope of this document but will be discussed in subsequent subsections.

Time code values may be critical to the correct operation of a spacecraft (for example, the exact time a maneuver burn should be accomplished), or may be non-critical (for example, a time tag on an image being downlinked from a spacecraft).

In the case of transmitting critical time codes, it is expected that integrity and possibly authentication may be required. Depending on other circumstances, there may also be a need to ensure confidentiality of the time code.

3.2 SECURITY CONCERNS

As previously stated, a critical time code transmission might need to have security services applied for protection. Depending on the threat, the mission security policy(s), and the desire of the mission planners, security services might need to be applied to the entity carrying the time code. If a time code is critical, it is important to ensure that it is not modified without detection during transmission. Authentication may also be required to ensure there can be no injection of erroneous/false time codes, which could change the spacecraft's knowledge of time.

While these security concerns are valid, they are outside the scope of this document. This document assumes that either upper or lower layers of the OSI model will provide the security services. That is, if authenticity at the granularity of a specific user is required, it is best applied at the Application layer. If less granularity is required, it could be applied at the Network or Data Link layers. If integrity is required, it can be applied at the Application, Network, or Data Link layer. Similarly, if confidentiality is required, it can be applied at the Application layer, Network layer, or Data Link layer. For more information regarding the choice of service and where it can be implemented, see reference [8].

3.3 POTENTIAL THREATS AND ATTACK SCENARIOS

Without authentication, unauthorized time codes might be uploaded to a spacecraft, changing the time basis. Without integrity, corrupted time codes might be uploaded to a spacecraft. Without confidentiality, the contents of the time code might be disclosed to an unauthorized entity.

3.4 CONSEQUENCES OF NOT APPLYING SECURITY

The security services are out of scope of this document and should be applied at layers above or below those specified in this document. However, should there be a requirement for authentication and it is not implemented, unauthorized time codes might be loaded onto a spacecraft potentially resulting in the loss of a mission. If integrity is not implemented, erroneous time codes might be loaded onto a spacecraft, also potentially resulting in the loss of the mission. If confidentiality is not implemented, time code or other parameters transmitted to or from a spacecraft might be visible to unauthorized entities resulting in disclosure of sensitive or private information.

E1 PB-5J

The NASA PB-5J time code is a segmented time code in which the segments represent, respectively, coarse time in truncated Julian day (TJD) and fine time in SI units with optional resolution to 1 nanosecond. The segment boundaries coincide with the octet boundaries. The length of the optional forms of PB-5J are all multiples of 8 bits.

The PB-5J code is constructed as follows:

			OPTIONAL			
	TJD	s of day	ms of s	µs of ms	ns of µs	PB-5J ID Code
SEGMENT WIDTH (bits)	16	24	16	16	16	8

Fill bits have been added in the most significant position of each segment to ensure that the segments end on octet boundaries.

For consistency with the CCSDS standard format, the P-field must be constructed as follows:

Bits 1 - 3	=	Time Code Identification :		110
Bits 4 - 7	=	Length PB-5JA	(6 octets):	0101
		PB-5JB	(8 octets):	0111
		PB-5JC	(10 octets):	1001
		PB-5JD	(12 octets):	1011

ANNEX F

INFORMATIVE REFERENCES

This annex **is not** part of the Recommendation.

~~[1] *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-7. Yellow Book. Issue 7. Washington, D.C.: CCSDS, November 1996.~~

[1] *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-9. Yellow Book. Issue 9. Washington, D.C.: CCSDS, November 2003.

[2] Bureau International de l'Heure Annual Report. Available from Monsieur le Directeur, Bureau International de l'Heure, 61 Avenue de l'Observatoire, 75014 Paris, France. Also available from: Superintendent, U.S. Naval Observatory, Time Service Division, Washington, D.C. 20390.

[3] Bureau International De l'Heure Circular D, Monthly Report. Available from Monsieur le Directeur, Bureau International de l'Heure, 61 Avenue de l'Observatoire, 75014 Paris, France. Can also be requested as Time Service Publication Series 15 from: Superintendent, U.S. Naval Observatory, Time Service Division, Washington, D.C. 20390.

[4] Recommendations and Reports of the CCIR, XVth Plenary Assembly, Geneva 1982, Vol. VII: Standard Frequencies and Time, as modified in 1983 and 1985, or later issue.

[5] *SI Units and Recommendations for the Use of Their Multiples and of Certain Other Units*. International Standard, ISO 1000:1992. 3rd ed. Geneva: ISO, 1992.

[6] *Data Elements and Interchange Formats—Information Interchange—Representation of Dates and Times*. International Standard, ISO 8601:2000. 2nd ed. Geneva: ISO, 2000.

[7] *Information Technology—8-Bit Single-Byte Coded Graphic Character Sets—Part 1: Latin Alphabet No. 1*. International Standard, ISO/IEC 8859-1:1998. Geneva: ISO, 1998.

[8] *The Application of CCSDS Protocols to Secure Systems*. Report Concerning Space Data System Standards, CCSDS 350.0-G-2. Green Book. Issue 2. Washington, D.C.: CCSDS, January 2006.

The latest issue of CCSDS documents may be obtained from the CCSDS Secretariat at the address indicated on page i.